

PORTSMOUTH HARBOR AND PISCATAQUA RIVER, MAINE  
AND N. H.

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LETTER

FROM

THE SECRETARY OF THE ARMY

TRANSMITTING

A LETTER FROM THE CHIEF OF ENGINEERS, UNITED STATES ARMY, DATED JUNE 4, 1952, SUBMITTING A REPORT, TOGETHER WITH ACCOMPANYING PAPERS AND ILLUSTRATIONS, ON A REVIEW OF REPORTS ON PORTSMOUTH HARBOR, N. H., AND ON PISCATAQUA RIVER, MAINE, AND N. H., WITH A VIEW TO DETERMINING THE ADVISABILITY OF FURTHER IMPROVEMENT IN THE INTEREST OF NAVIGATION AT THIS TIME, REQUESTED BY A RESOLUTION OF THE COMMITTEE ON PUBLIC WORKS, HOUSE OF REPRESENTATIVES, ADOPTED ON FEBRUARY 17, 1949

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SEPTEMBER 30, 1952.—Referred to the Committee on Public Works and ordered to be printed with two illustrations (pursuant to Public Law 504, 82d Cong.)

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LETTER OF TRANSMITTAL

DEPARTMENT OF THE ARMY,  
*Washington, D. C., August 12, 1952.*

The SPEAKER OF THE HOUSE OF REPRESENTATIVES.

DEAR MR. SPEAKER: I am transmitting herewith a report dated June 4, 1952, from the Chief of Engineers, United States Army, together with accompanying papers and illustrations, on a review of reports on Portsmouth Harbor, N. H., and on Piscataqua River, Maine and N. H., with a view to determining the advisability of further improvement in the interest of navigation at this time, requested by a resolution of the Committee on Public Works, House of Representatives, adopted February 17, 1949.

In accordance with section 1 of Public Law 14, Seventy-ninth Congress, the views of the States of Maine and New Hampshire are set forth in the enclosed communications.

The Bureau of the Budget advises that there is no objection to the submission of the report to Congress. The complete views of the Bureau of the Budget are contained in the attached copy of its letter.

Sincerely yours,

KARL R. BENDETSSEN,  
*Acting Secretary of the Army.*

#### COMMENTS OF THE BUREAU OF THE BUDGET

EXECUTIVE OFFICE OF THE PRESIDENT,  
BUREAU OF THE BUDGET,  
*Washington, D. C., July 25, 1952.*

The honorable the SECRETARY OF THE ARMY

(Through the Budget Officer for the Department of the Army).

MY DEAR MR. SECRETARY: Receipt is acknowledged of your letter dated June 12, 1952, submitting the proposed report of the Chief of Engineers on Portsmouth Harbor, N. H., and on Piscataqua River, Maine and N. H., requested by resolution of the Committee on Public Works, House of Representatives, adopted February 17, 1949.

I am authorized by the Director of the Bureau of the Budget to advise you that there would be no objection to the submission of the report to Congress.

Sincerely yours,

CARL H. SCHWARTZ, Jr.,  
*Chief, Resources and Civil Works Division.*

#### COMMENTS OF THE STATE OF NEW HAMPSHIRE

STATE OF NEW HAMPSHIRE,  
*Concord, May 1, 1952.*

Maj. Gen. G. J. NOLD,

*Acting Chief of Engineers, Department of the Army,  
Washington, D. C.*

DEAR GENERAL NOLD: You have asked for our views relative to the report submitted by the Corps of Engineers for the development of Portsmouth Harbor and the Piscataqua River.

At my suggestion, Chairman Walter G. White of the New Hampshire Water Resources Board recently conducted a meeting in Portsmouth with some 19 major water-front users, and representatives of the Portsmouth city government. The unanimous belief expressed by those present was that plan A, as recommended by the Army engineers, is not only desirable but of some urgency. It was brought out at the meeting that Portsmouth Harbor has the highest per ton risk of any harbor in this section of the country, and faces increasing difficulty in meeting the growing traffic demands.

Those at the meeting, while offering the opinion that the eventual adoption of plan B may well be in the public interest, for the most

part agreed that at present there is inadequate evidence available to support its undertaking at this time.

May I here express my full agreement that plan A, as you have recommended it, should be undertaken, and as promptly as possible.

Sincerely yours,

SHERMAN ADAMS, *Governor.*

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COMMENTS OF THE STATE OF MAINE

STATE OF MAINE,  
PUBLIC UTILITIES COMMISSION,  
*Augusta, May 27, 1952.*

CHIEF OF ENGINEERS,

*Department of the Army, Washington, D. C.*

(Attention C. H. Chorpeneing, brigadier general, United States Army.)

DEAR GENERAL CHORPENING: Reference is made to your letter of May 22, 1952, your file ENGWD, which relates to a copy of the proposed report of the Chief of Engineers on a review of reports on Portsmouth Harbor and Piscataqua River, Maine and N. H.

This is to advise that no comments will be made by the State of Maine.

Very truly yours,

MINER R. STACKPOLE,  
*Engineer, Water Resources Division.*

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REPORT OF THE CHIEF OF ENGINEERS, UNITED STATES ARMY

DEPARTMENT OF THE ARMY,  
OFFICE OF THE CHIEF OF ENGINEERS,  
*Washington, D. C., June 4, 1952.*

Subject: Portsmouth Harbor and Piscataqua River, Maine and N. H.

To: The Secretary of the Army.

1. I submit herewith for transmission to Congress the report of the Board of Engineers for Rivers and Harbors in response to resolution of the Committee on Public Works of the House of Representatives, adopted February 17, 1949, requesting the Board to review the reports on Portsmouth Harbor, N. H., submitted in House Document 1010, Sixty-fourth Congress, first session, and prior reports, and on Piscataqua River, Maine and N. H., submitted in Senate Executive Document 44, Forty-eighth Congress, first session, with a view to determining the advisability of further improvement in the interest of navigation at this time, including the removal of Gangway Rock and improvement work at the southwest point of Badgers Island.

2. After full consideration of the report secured from the division engineer, the Board recommends modification of the existing project for Portsmouth Harbor to provide for the removal of ledge rock in the vicinity of Gangway Rock, the southwest point of Badgers Island, and Boiling Rock, to 35 feet below mean low water, all generally in accordance with plans of the division engineer and with such modifications

thereof as in the discretion of the Chief of Engineers may be advisable; at an estimated cost to the United States of \$834,000 for the rock removal and with no additional annual maintenance required, subject to the condition that local interests give assurances satisfactory to the Secretary of the Army that they will (a) furnish free of cost to the United States all lands, easements, and rights-of-way necessary for construction of the project, and (b) hold and save the United States free from damages due to the construction works.

3. After due consideration of this report, I concur in the views and recommendations of the Board.

LEWIS A. PICK,  
*Lieutenant General,*  
*Chief of Engineers.*

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REPORT OF THE BOARD OF ENGINEERS FOR RIVERS AND  
HARBORS

CORPS OF ENGINEERS, UNITED STATES ARMY,  
BOARD OF ENGINEERS FOR RIVERS AND HARBORS,  
*Washington, D. C., January 15, 1952.*

Subject: Portsmouth Harbor and Piscataqua River, Maine and N. H.  
To: The Chief of Engineers, United States Army.

1. This report is submitted in response to the following resolution adopted February 17, 1949:

*Resolved by the Committee on Public Works of the House of Representatives, United States, That the Board of Engineers for Rivers and Harbors be, and is hereby, requested to review the reports on Portsmouth Harbor, New Hampshire, submitted in House Document Numbered 1010, Sixty-fourth Congress, first session, and prior reports, and on Piscataqua River, Maine and New Hampshire, submitted in Senate Executive Document Numbered 44, Forty-eighth Congress, first session, with a view to determining the advisability of further improvement in the interest of navigation at this time including the removal of Gangway Rock and improvement work at the southwest point of Badgers Island.*

2. Piscataqua River, Maine and N. H., formed by the confluence of Salmon Falls and Cocheco Rivers, flows 13 miles generally southeast to the Atlantic Ocean. The lower portion of the river, known as Portsmouth Harbor, is 55 miles northeast of Boston. Channel depths and widths from the mouth of the river to mile 8 generally exceed 40 and 500 feet, respectively. The mean range of tide at the harbor entrance is 8.7 feet. Gangway Rock is a ledge projecting into the channel opposite the Portsmouth Naval Base on Seavey Island. Badgers Island is on the north side of the channel 3,300 feet upstream from Gangway Rock. A submerged ledge off the southwest end of this island and one called Boiling Rock, 1.6 miles above the island, also encroach upon the channel. General navigation throughout the entire length of the Piscataqua River is hampered by rapid tidal currents. There is no Federal project for improvement of the river above Portsmouth Harbor. The authorized Federal project for Portsmouth Harbor provides for a stone breakwater extending from Goat Island to Newcastle Island, the removal of a portion of Gangway Rock to a depth of 20 feet below mean low water, the removal of a portion of ledge on the southwest side of Badgers Island to a depth of 18 feet below mean low water, and the removal of Pier Rock to a depth of 12 feet below mean low water. The project was completed in 1892. Total expenditures have been \$130,393, all for new work.



3. The immediate tributary area comprises the city of Portsmouth and the towns of Newington, N. H., and Kittery, Maine, with a combined population of 27,400. Principal activities in this area include the manufacture of shoes and gypsum products, generation of electrical power, and the operation of coal and petroleum distribution terminals and the Portsmouth Naval Base. In addition to those at the naval base there are 14 wharves within the limits of Portsmouth Harbor, of which 10 are on the Portsmouth side and 4 on the Kittery side. On the Portsmouth side, three of the wharves are unserviceable for further navigation use and one is being dismantled. The principal terminals for deep-draft commercial vessels are along the Piscataqua River above Portsmouth Harbor proper. On the westerly bank of the river in this section there are four wharves serving seven industries and bulk fuel terminals. Large tracts of land adjacent to the river are available for future development. Commerce of Portsmouth Harbor and Piscataqua River for the years 1940 through 1949 fluctuated between a low of 200,570 tons in 1943 and a high of 571,830 tons in 1941 and averaged 357,200 tons annually during that period. The commerce during 1949 amounted to 505,480 tons and consisted principally of petroleum and its products, gypsum, and coal. During that year there were 21 round trips of vessels drawing from 24 to 33 feet; 173, drawing from 12 to 24 feet; and 4,244, drawing under 12 feet. The area is served by highways and a railroad.

4. Local interests desire removal of Gangway Rock and a portion of the rock at the southwest point of Badgers Island to a depth of 30 to 35 feet below mean low water, and removal of Boiling Rock in the Piscataqua River to a depth of 30 feet below mean low water. They state that swift currents in the waterway limit navigation to periods of 1.5 hours before and after slack water. The three ledges are located at points involving extremely dangerous navigational difficulties. Their removal would permit safer navigation and maneuvering, particularly for deep-draft vessels of 10,000 tons or more. Local interests also state that vessels have struck all the ledges and that one accident resulted in a loss of \$420,000. The principal claim for the necessity of the improvement is based on the expanding industrial use of the shores of the Piscataqua River which has resulted in increased commerce on the waterway. No offer of local cooperation is made.

5. The division engineer considered two plans of improvement. Plan A meets the desires of shipping interests with deep-water terminals located upstream as far as Boiling Rock. It would provide for the removal of ledge rock at Gangway Rock, the southwest point of Badgers Island, and Boiling Rock to a depth of 35 feet at mean low water. Plan B would provide for the removal of two shoal areas, located about 1 mile and 1.8 miles upstream of Boiling Rock, to 35 feet below mean low water. The division engineer reports that plan B would cost \$324,000, of which \$320,000 is for construction and \$4,000 is for aids to navigation. He estimates the annual carrying charges at \$14,000 and the annual benefits at \$3,300. The benefit-cost ratio is 0.2. He concludes that plan B is not economically justified. The division engineer estimates the cost to the United States for plan A at \$864,000, of which \$834,000 is for rock removal and \$30,000 is for aids to navigation. The only Federal annual maintenance cost will be that for aids to navigation, estimated at \$600. The annual carrying

charges are estimated at \$34,200, all Federal. He estimates the annual benefits at \$48,550, of which \$20,000 is from elimination of vessel damages and \$28,550 is from the saving in costs of vessel operation. The benefit-cost ratio is 1.4. The division engineer concludes that plan A is economically justified and recommends the improvement subject to the condition that local interests furnish the necessary lands, easements, and rights-of-way, and hold and save the United States free from damages due to the construction works.

6. Local interests were informed of the recommendations of the division engineer and invited to submit additional information to the Board. Careful consideration has been given the communications received.

#### VIEWS AND RECOMMENDATIONS OF THE BOARD OF ENGINEERS FOR RIVERS AND HARBORS

7. The Board of Engineers for Rivers and Harbors concurs generally in the views of the division engineer. Removal of shoal areas upstream of Boiling Rock is not economically justified at this time. However, the Board is of the opinion that the removal of ledge rock at Gangway Rock, the southwest point of Badgers Island, and Boiling Rock, is justified both by the monetary benefits and in the interest of increased safety and convenience to established navigation.

8. Accordingly, the Board recommends modification of the existing project for Portsmouth Harbor to provide for the removal of ledge rock in the vicinity of Gangway Rock, the southwest point of Badgers Island, and Boiling Rock, to 35 feet below mean low water, all generally in accordance with plans of the division engineer and with such modifications thereof as in the discretion of the Chief of Engineers may be advisable; at an estimated cost to the United States of \$834,000 for the rock removal and with no additional annual maintenance required, subject to the condition that local interests give assurances satisfactory to the Secretary of the Army that they will (a) furnish free of cost to the United States all lands, easements, and rights-of-way necessary for construction of the project, and (b) hold and save the United States free from damages due to the construction works.

For the Board:

G. J. NOLD,  
*Major General,*  
*Chairman.*

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#### REPORT OF THE DIVISION ENGINEER

##### SYLLABUS

The division engineer finds that prospective benefits are sufficient to warrant the improvement of Portsmouth Harbor and Piscataqua River, N. H. and Maine. He recommends modification of the existing project to include the removal of ledge rock to 35 feet below mean low water in the vicinity of Gangway Rock, the southwest point of Badgers Island, and Boiling Rock, all as shown on plates 1 and 2 accompanying this report. The removal of the ledge rock is estimated to cost \$834,000. No maintenance is anticipated to be necessary. These estimates are exclusive of costs of aids to navigation.

The division engineer further finds that the prospective benefits are insufficient to warrant improvement of the waterway upstream of Boiling Rock at this time.

DEPARTMENT OF THE ARMY,  
CORPS OF ENGINEERS,  
NEW ENGLAND DIVISION,  
Boston, Mass., June 29, 1951.

Subject: Survey (review of reports) of Portsmouth Harbor and Piscataqua River, N. H. and Maine.

To: The Chief of Engineers, United States Army, Washington, D. C.

AUTHORITY

1. This report is submitted in compliance with the following resolution adopted February 17, 1949, by the Committee on Public Works of the House of Representatives, United States Congress:

*Resolved by the Committee on Public Works of the House of Representatives, United States, That the Board of Engineers for Rivers and Harbors be, and is hereby, requested to review the reports on Portsmouth Harbor, New Hampshire, submitted in House Document Numbered 1010, Sixty-fourth Congress, first session, and prior reports, and on Piscataqua River, Maine and New Hampshire, submitted in Senate Executive Document Numbered 44, Forty-eighth Congress, first session, with a view to determining the advisability of further improvement in the interest of navigation at this time including the removal of Gangway Rock and improvement work at the southwest point of Badgers Island.*

A study of survey scope was authorized by the Chief of Engineers on March 22, 1949.

REPORTS UNDER REVIEW

2. The report under review for Portsmouth Harbor, published in House Document 1010, Sixty-fourth Congress, first session, is a preliminary examination in which a recommendation of further study of Portsmouth Harbor was made by the district engineer. The Board of Engineers for Rivers and Harbors, in its review of the district engineer's report, found that an effective improvement would be prohibitive in cost and that it was inadvisable for the United States to undertake the improvement at that time. The Chief of Engineers concurred with the views of the Board. The report under review for the Piscataqua River, published in Senate Executive Document 44, Forty-eighth Congress, first session, is a preliminary examination and survey at or near Great Bay, and is favorable to the construction of a dam about 1 mile below the mouth of Great Bay as a method of arresting the swift tidal currents prevailing in the river. The estimated cost of the dam was \$710,000. Congress did not adopt this project.

DESCRIPTION

3. The Piscataqua River forms a portion of the boundary between the States of Maine and New Hampshire. The mouth of this river is called Portsmouth Harbor. It is 45 miles sailing distance north-east of Boston Harbor, Mass., and 37 miles sailing distance south-west of Portland Harbor, Maine.

4. The Piscataqua River is about 13 miles long and has a tortuous channel which winds around sharp bends and over submerged ledges, making its navigation hazardous. The river begins at the confluence of the Salmon Falls and Cochecho Rivers. These latter rivers are navigable for small boats and have controlling depths of 7 feet for a

distance of about 1 mile and  $2\frac{1}{2}$  miles, respectively. Below the confluence, the Piscataqua River flows in a southern direction for about 4 miles to a point where it receives the discharge of a 12-square-mile tidal basin consisting of Great Bay and its tributary rivers. Within this 4-mile reach, the Piscataqua River has a natural channel about 400 feet wide in which depths vary from 9 to 28 feet, with 9 feet being the controlling depth in the upper half of the channel and 20 feet in the lower half. Below the junction with the Great Bay waterway system, the Piscataqua River swings southeast for a distance of about 3 miles in which the depth of the natural channel is in excess of 40 feet except for two shoal areas, one about 1 mile upstream of Boiling Rock, and an edge shoal about 0.8 mile further upstream. Immediately at the lower end of this reach is a submerged ledge called Boiling Rock, about 200 feet from the left bank, which reduces the width of the usable natural channel section to less than 400 feet. Just below Boiling Rock the river abruptly swings east for about 3,000 feet and then again swings southeast for about 1 mile to the submerged ledges at the southwest point of Badgers Island. The least channel width in this river reach is 500 feet and depths vary from 47 to 71 feet with the depth being generally in excess of 50 feet. About one-half mile above Badgers Island the river is crossed by a two level highway and railroad bridge which marks the upper limit of Portsmouth Harbor. At Badgers Island the course swings back to an easterly direction for about 3,000 feet to Gangway Rock. A highway bridge crosses the river in this reach at Badgers Island. A submerged ledge off the southwest end of Badgers Island encroaches on the channel reducing the available width to less than 400 feet. Gangway Rock marks an area opposite the Portsmouth Naval Base where the direct approach to Memorial Bridge is constricted by rock shoals on both edges of the channel. Channel depths in this reach vary from 39 to 72 feet except for the rock shoals, where the controlling depths are 20 feet and 33 feet. At Gangway Rock, the river makes a very sharp bend to the south, continues the course for about 3,000 feet, at which point it swings east for about  $1\frac{1}{2}$  miles and then swings south again for the entrance. Channel depths generally in excess of 50 feet, and widths in excess of 500 feet exist in the lower section of Portsmouth Harbor.

5. Rapid tidal currents prevail throughout the entire river. The average velocity at full strength of the current at Seavey Island is 3.9 knots; at Gangway Rock is 2.6 knots; and at Boiling Rock is 4 knots. The mean range of tide at the entrance is 8.7 feet, and the spring range is 10 feet. At Portsmouth the mean range is 7.8 feet, and the spring range is 9 feet. At the mouth of the Salmon Falls River the mean range is 6.6 feet, and the spring range is 7.6 feet. The locality is shown on United States Coast and Geodetic Survey charts Nos. 229, 329, 1206, and on plates 1 and 2 accompanying this report.

#### TRIBUTARY AREA

6. The immediate tributary area of Portsmouth Harbor and the Piscataqua River comprises the city of Portsmouth, the town of Newington, N. H., and the town of Kittery, Maine. Portsmouth in



1950 had a population of 18,793 and in 1948 had a real-estate valuation of \$26,012,526. Newington had a population in 1950 of 490, and a real-estate valuation in 1948 of \$975,864. Kittery in 1950 had a population of 8,088, and in 1948 a real-estate valuation of \$2,520,548. The principal industries of the area are the manufacture of shoes and gypsum products, generation of electrical power, operation of bulk coal and petroleum-products distribution terminals, and the Portsmouth Naval Base. Within 15 miles of Portsmouth and on the navigable tributaries of the Piscataqua River are the cities of Dover and Somersworth and the towns of Durham and Newmarket, N. H., and the town of South Berwick, Maine. Dover and Somersworth, with populations of 15,900 and 6,900, respectively, are manufacturing centers principally engaged in the production of textiles, leather and leather products, and electrical equipment. The electrical-equipment plants are a recent addition to the industry of the area. Newmarket, N. H., and South Berwick, Maine, with populations in 1950 of 2,722 and 2,630, respectively, are engaged in the manufacture of leather products. Durham, N. H., is the site of the University of New Hampshire, and had a population of 4,721 in 1950. The Boston & Maine Railroad serves most communities in the area. A main line to Portland, Maine, passes through Portsmouth, and a branch line runs along the westerly bank of the Piscataqua River on which the major industries are located. The area is also served by bus lines and trucking companies which operate over a network of hard-surfaced roads.

## BRIDGES

7. Two bridges, as described below, cross the river from the city of Portsmouth, N. H., to the town of Kittery, Maine, in the area considered in this report. The first, plans for which were approved by the War Department on December 16, 1920, spans the river at Badgers Island. The second, plans for which were approved by the War Department on June 25, 1938, spans the river at Nobles Island.

Miles above mouth	Kind	Clearance in feet			Use	Owner	Year completed
		Horizontal	Minimum vertical height above mean high water				
			Down	Raised			
3.5-----	Vertical lift---	260	19.1	150	Highway-----	U. S. Government, State of Maine, State of New Hampshire.	1923
4.0-----	---do-----	200	10.2	135	Highway and railroad.	Maine-New Hampshire Interstate Bridge Authority.	1940

## PRIOR REPORTS

8. Portsmouth Harbor and Piscataqua River have been the subject of several previous reports. Pertinent data with reference to these reports are embodied in the following table:

Published in—	Nature and date of report	Work considered and recommendations
H. Ex. Doc. 84, 43d Cong., 1st sess.	Preliminary examination, 1873.	Breakwater between Gerrish and Wood Islands. Estimated costs, \$150,000. Favorable.
S. Ex. Doc. 29, 45th Cong., 3d sess.	Survey, 1878.-----	Closing channel between Newcastle Island and Goat Island to eliminate strong cross currents. Remove portion of Gangway Rock to 20 feet below mean low water. Remove part of Badgers Island to 10 feet at mean low water. Favorable.
S. Ex. Doc. 30, 48th Cong., 1st sess.	Preliminary examination, 1882.	Extension and completion of breakwater between Goat Island and Newcastle Island. Unfavorable.
S. Ex. Doc. 44, 48th Cong., 1st sess.	Preliminary examination and survey, 1883.	Construction of dam near mouth of Great Bay to maintain high-water-level navigation above and eliminate strong currents below. Unfavorable.
H. Ex. Doc. 71, 48th Cong., 2d sess.	Preliminary examination, 1884.	Improvement of Portsmouth Harbor. Unfavorable.
H. Doc. 39, 56th Cong., 1st sess.	Preliminary examination, 1899.	Removal of "Pull-and-Be-Dammed Point." Unfavorable.
H. Doc. 263, 56th Cong., 2d sess.	Preliminary examination and survey, 1900.	Remove portion of Henderson Point to improve navigation into Navy Yard at Kittery. Favorable—completed by Navy.
H. Doc 1086, 61st Cong., 3d sess.	Preliminary examination (review of reports), 1909.	Construction of lock and dam in Piscataqua River. Unfavorable.
H. Doc. 1010, 64th Cong., 1st sess.	Preliminary examination, 1915.	Removal of South Beacon Shoal, part of Shoal off Badgers Island, part of Gangway Rock, Goat Island and Seawards Rock, all to a depth of 30 feet below mean low water. Unfavorable.

#### EXISTING CORPS OF ENGINEERS PROJECT

9. The existing Corps of Engineers project in the waterway is for Portsmouth Harbor only, and is the original project which was authorized by the River and Harbor Act of 1879 and modified in 1890. It provides for a stone breakwater extending from Goat Island to Newcastle Island, the removal of a portion of Gangway Rock to depth of 20 feet below mean low water, the removal of a portion of ledge on the southwest side of Badgers Island to depth of 18 feet below mean low water, and the removal of Pier Rock to a depth of 12 feet below mean low water. Work has never been authorized in the Piscataqua River above Portsmouth Harbor.

10. Work on the project was initiated in 1879, and the entire project completed in 1892. The breakwater, which was designed to eliminate dangerous cross currents in the vicinity of Goat Island Ledge, was completed in 1881. Removal of Gangway Rock to project depth began in 1881 and was completed in 1888. Removal of ledge at the southwest point of Badgers Island to project depth was started in 1881 and completed in 1891. Removal of Pier Rock to project depth, as authorized by the River and Harbor Act of 1890, was accomplished in the 2-year period 1891 to 1892.

11. The total expenditures in Portsmouth Harbor have been \$130,392.61, all of which have been for new work.

#### LOCAL COOPERATION ON EXISTING AND PRIOR PROJECTS

12. Local cooperation was not required on the existing project, which is the only project ever authorized for Portsmouth Harbor or Piscataqua River.

## OTHER IMPROVEMENTS

13. Local or State interests have provided no improvement for the benefit of general navigation. However, Portsmouth, N. H., and Kittery, Maine, have provided free public landings for the use of small craft in Portsmouth Harbor. About 50 years ago the Navy removed a portion of Henderson Point to improve navigation into the naval base.

## TERMINAL AND TRANSFER FACILITIES

14. There are 14 wharves within the limits of Portsmouth Harbor in addition to those at the naval base, 10 of which are on the Portsmouth side and 4 on the Kittery side. On the westerly bank of the Piscataqua River, in the reach considered in this report, there are four wharves serving seven major industries and bulk fuel terminals.

15. On the Portsmouth side of the harbor, three of the wharves are owned by the Boston & Maine Railroad and are unserviceable for further use by navigation. All three wharves are generally pile and timber piers projecting from granite bulkheads. Two other wharves, owned by the Pittsburg Consolidation Coal Co. and the New Hampshire Gas & Electric Co., are used solely for the unloading, transfer, and storage of coal. The Pittsburg Consolidation Coal Co. wharf has a berthing space of 400 feet, with a depth of 16 to 17 feet below mean low water. It has two steam-operated movable hoists with a total capacity of 300 tons per hour. Rock shoals fronting this wharf have prevented the economic deepening of the berth for receipt of modern deep-draft colliers. Consequently, this company no longer receives coal by water carrier and plans to dismantle the handling equipment. The wharf will be used for storage of land-transported coal. The New Hampshire Gas & Electric Co. wharf is a marginal structure with 363 feet of berthing space, having a depth of 20 feet at mean low water. The Coleman Oil Co. has an L-shaped pier with 100 feet of berthing space at its end which is 22 feet deep at mean low water. It is used principally for the receipt of petroleum products. There is also one wharf used exclusively for the receipt of fish and lobsters with a berthing space of 260 feet which is 10 feet deep at mean low water. Two other wharves are also located in the Portsmouth area. One is a small wharf operated by the Isles of Shoals Steamboat Co. and has a berthing space of 80 feet with a depth of 12 feet at mean low water. The other is a public landing maintained by the city of Portsmouth and has 240 feet of berthing space with a depth of 6 feet at mean low water.

16. The naval base, located on Seavey Island opposite Gangway Rock, has a number of wharves adjacent to the channel which are used in connection with the construction and repair of naval craft. Petroleum products and other commodities for Navy use are received at these wharves.

17. On the Kittery side of the harbor, there is an inactive coal wharf owned by George D. Boulter Co., with 131 feet of berthing space at an average depth of 13 feet at mean low water. It has one fixed steam-operated coal hoist with a total capacity of 250 tons per hour. Another wharf, Warren's wharf, is used principally for the receipt of fish and has 260 feet of berthing space at depths of 15 feet below mean low water. A third wharf, the William Wurm pier, is

equipped with marine fuel service for small boats and has a ramp and float, with a depth of 6.0 feet at mean low water at the float. The town of Kittery also provides a wharf which has 105 feet of berthing space having a depth of 4.0 feet at mean low water, which is used principally by recreational craft.

18. The principal terminals for modern use of the waterway by deep-draft commercial vessels are located along the Piscataqua River above Portsmouth Harbor proper. About one-half mile above Portsmouth Harbor is located the National Gypsum Co. plant. This company has a marginal wharf, consisting of solid fill retained by a steel sheet-pile bulkhead, which provides 300 feet of berthing space having a depth of 23 feet at mean low water. There are two movable, electrically operated hoists, with capacities of 2 tons single lift, for handling gypsum rock. In addition, this wharf is used by the adjacent bulk distribution plant of the Esso Standard Oil Co., which has storage capacity of 208,000 barrels.

19. About 1 mile further upstream, in the vicinity of Boiling Rock, the Public Service Co. of New Hampshire has established a principal power installation, the Schiller station, which comprises a floating power plant, the steamship *Resistance*, and a mercury-vapor power plant. Located immediately adjacent to the mercury-vapor plant are the regional bulk-distribution terminals of C. H. Sprague & Son Co., dealers in coal and oil, and the Socony-Vacuum Oil Co., Inc. The power company itself owns oil tanks having storage capacity of 110,000 barrels for operating the floating power plant steamship *Resistance*. C. H. Sprague & Son Co. owns oil tanks having storage capacity of 192,000 barrels. This company furnishes coal and oil to the power company for operating the mercury-vapor plant, and to other industries in the region. The Socony-Vacuum Oil Co., Inc., has a storage capacity of 405,000 barrels. Oil for the power company's storage tanks and for the Socony-Vacuum Co.'s storage tanks is received at a jointly owned T-head wharf which provides sufficient berthing length and depth to accommodate deep-draft tankers. The wharf consists of a wood deck supported by two concrete-filled dolphins, three rock-filled timber cribs, and a concrete pier. The head of the wharf is about 300 feet long. The coal and oil for C. H. Sprague & Son Co. is received at a new wharf constructed by the power company about 500 feet upstream from the above-described wharf. The wharf consists of a 400-foot-long concrete deck resting on continuous built-up steel girders supported by concrete-filled caissons. Installed on the wharf are two electrically operated coal hoists of 5-ton capacity and modern conveyor systems connecting with C. H. Sprague & Son Co.'s coal yard and the adjacent rail siding. Steam-heated pipes are also provided for discharging oil cargoes. The berth provides a depth of 32 feet at mean low water. The floating power plant steamship *Resistance* has a length of about 350 feet and a beam of about 50 feet, and is moored to two dolphins about 200 feet downstream from the first-described wharf. A permanent pier extends from the shore to one of the dolphins.

20. Approximately 2 miles above the Public Service plant is a wharf owned and operated by the Atlantic Terminal Sales Corp. The wharf is a T-head wharf of timber and pile construction. It has berthing space of 100 feet on its end with a depth of 16 feet at mean low



water. It is used principally for the receipt of petroleum products. Oil storage is provided for 114,000 barrels by the Atlantic Terminal Sales Corp., which is the local distributor for the Gulf Oil Corp. Oil storage for 28,000 barrels is also provided by the Shell Oil Co., Inc., which leases its tanks from the Atlantic Terminal Sales Corp. and uses its wharf. There are four rail sidings at this terminal used for shipment of oil.

21. The modern commercial harbor of this waterway has been shifted from Portsmouth Harbor to the reach of the Piscataqua River considered herein. This shift has been made due to the change in size of vessels employed in coastwise traffic, types of cargo handled, and the need of large land areas for industrial development, particularly for fuel storage. Large tracts of land adjacent to the river are available for future development, part of which have been considered for establishing a steel mill. The new 40,000-kilowatt mercury-vapor power plant of the Public Service Co. of New Hampshire is the first of three units planned for construction at the site as power demands increase. The Atlantic Terminal Sales Corp. has plans and specifications prepared for the construction of four additional oil tanks having storage capacity for 280,000 barrels and for a wharf providing berthing depths of 36 to 37 feet.

#### IMPROVEMENT DESIRED

22. A public hearing was held by the division engineer on July 12, 1949, at Portsmouth, N. H., in order to determine the improvements desired by local interests. Present at the hearing were representatives of State and local governments, the commander of the United States naval base at Kittery, representatives of various industries, and residents of the area. Two previous hearings were held at Portsmouth, one of which was held by a Representative in Congress on December 22, 1948, the other by the New Hampshire Seacoast Regional Development Association on January 14, 1949. At the July hearing, a brief detailing the desired improvements was submitted jointly by the State of New Hampshire, the New Hampshire Planning and Development Association, the New Hampshire Seacoast Regional Development Association, the city of Portsmouth, and the Portsmouth Chamber of Commerce. The brief was based on the results of the previous hearings.

23. The improvements proposed at the hearing were as follows:

(a) Removal of Gangway Rock at the entrance to Portsmouth Harbor to a depth of 30 to 35 feet below mean low water;

(b) Removal of a portion of rock at the southwest point of Badgers Island to a depth of 30 to 35 feet below mean low water;

(c) Removal of Boiling Rock in the Piscataqua River to a depth of 30 feet below mean low water.

24. Local interests desire these improvements to allow safer navigation and maneuvering, particularly for deep-draft vessels of 10,000 tons or more. Swift currents in the waterway limit its navigation to periods of about 1.5 hours before and after slack water. The three ledges are located at points involving extremely hazardous navigational difficulties. Gangway Rock is located on a bend opposite the naval base where avoidance of the ledge interferes with the movement of

vessels at the base. The ledge at the southwest point of Badgers Island occurs at a bend in the channel between two bridges, at a point where vessels must maneuver for passageway through both bridges. Boiling Rock is located in a constricted reach of the river, opposite the docks of the power plant and two bulk-fuel terminals. This ledge area interferes with the passage of vessels further upstream and with the turning of vessels at the adjacent docks. Cross currents in the vicinity of the ledges make the handling of vessels difficult. Local interests state that vessels have struck all ledges. One accident resulted in losses amounting to about \$420,000 when an outbound tanker struck Badgers Island ledge in avoiding an inbound tanker.

25. The principal claim for the necessity of the improvement at this time is based upon the expanding industrial use of the shores of the Piscataqua River, which has resulted in increased commerce on the waterway, particularly in petroleum products and coal for power development and regional distribution. It was pointed out that the wrecking of a loaded tanker on one of the ledges would endanger the city of Portsmouth by spreading highly inflammable liquids along the entire water front. It was claimed that the improvements could be justified by savings effected in insurance rates on vessels and in transportation charges by use of larger vessels.

#### COMMERCE

26. Petroleum, gypsum, and coal constitute the principal items of water-borne commerce for Portsmouth Harbor and Piscataqua River at the present time. The tonnage handled during the period 1940 through 1949 is indicated in the following tabulation, together with a detailed statement for the year 1949.

*Comparative statement of traffic*

Year	Short tons	Year	Short tons
1940.....	405, 553	1945.....	231, 346
1941.....	571, 828	1946.....	282, 484
1942.....	203, 747	1947.....	398, 841
1943.....	200, 566	1948.....	540, 852
1944.....	231, 301	1949.....	505, 480

Preliminary figures for the year 1950 show that the water-borne commerce was approximately 720,000 tons. The increase in commerce over that of 1949 is due primarily to the fuel requirements of the new mercury-vapor power plant which began operations at the end of 1949.

*Freight traffic, 1949*

[Short tons]

Commodity	Total	Foreign imports	Domestic		
			Coastwise		Local
			Receipts	Shipments	
Fish, fresh or frozen except shellfish.....	11				11
Shellfish and shellfish products.....	60				60
Anthracite coal.....	3,572		3,572		
Bituminous coal and lignite.....	52,151		52,151		
Gas oil and distillate fuel oil.....	83,446		83,446		
Motor fuel and gasoline.....	92,240		92,240		
Kerosene.....	63,210		63,210		
Residual fuel oil (including bunker oil).....	109,433		109,433		
Lubricating oils and greases.....	5,553		5,553		
Petroleum products, n. e. c.....	3,820		3,820		
Nonmetallic minerals, n. e. c.....	91,783	91,783			
Steel ingots, blooms, billets, slabs, etc.....	200			200	
Commodities, n. e. c.....	1			1	
Total.....	505,480	91,783	413,425	201	71

The above totals do not include a total of about 90,000 tons of petroleum products delivered to the United States naval base in 1949.

## VESSEL TRAFFIC

27. A statement, in tabular form, of commercial-vessel traffic for the period of 1940 to 1949, inclusive, follows:

*Vessel trips, in-bound and out-bound*

Draft (feet)	1940	1941	1942	1943	1944	1945	1946	1947	1948	1949
30 to 33.....								1	1	5
28 to 30.....		6	1	1	1			7	6	12
26 to 28.....		3	6	2	3	3	3	4	4	2
24 to 26.....	1	1		3	5			15	2	2
22 to 24.....	31	11	7	12	1				10	4
20 to 22.....	1	22	6	3	3				2	12
18 to 20.....	4	9	5	3	1	1	2		18	11
16 to 18.....	62	76	29	15	7	37	90	21	23	20
14 to 16.....	111	90	31	16	52	36	33	71	22	23
12 to 14.....	53	52	21	12	15	88	55	127	48	103
Under 12.....	837	864	368	233	404	727	1,233	640	1,194	4,244
Total.....	1,100	1,134	474	300	492	892	1,416	886	1,330	4,438

In addition to the foregoing, in 1949, miscellaneous naval craft, including 5 deep-draft tankers, made about 125 trips to and from the United States naval base.

28. The use of the waterway by deep-draft vessels is expected to increase in the future. The Public Service Co. of New Hampshire has plans to construct the second unit of the power plant within the next 2 years, with the third unit depending on the load demand. The Atlantic Terminal Sales Corp. has indicated that, if the improvements are made, they plan to install additional storage with a capacity of 280,000 barrels and construct a deep-water terminal.

## DIFFICULTIES ATTENDING NAVIGATION

29. General navigation throughout the entire length of the Piscataqua River is severely hampered by rapid tidal currents. The velocities of these currents differ at various locations because of the irregularities of the river's width and depth. The maximum average velocity in the river occurs immediately north of Nobles Island and amounts to 4.0 knots. The minimum average velocity occurs immediately east of Badgers Island and amounts to 0.8 knot. The irregularities of the river's width and depth plus the abrupt directional changes of its course result in changes in the direction of the currents which at some locations do not coincide with the channel's direction and create hazardous cross currents. As a result of the combination of the rapid tidal currents and hazardous cross currents, navigation of deep-draft vessels is limited to the 3-hour period consisting of 1½ hours before and 1½ hours after slack high water during daylight hours.

30. Particularly hazardous navigational difficulties prevail at the three submerged ledges at which improvements are desired. Gangway Rock, the first encountered in the river, is situated immediately opposite the wharves of the naval base on Seavey Island. At this point the natural channel makes a very sharp turn around the rock, with the result that strong cross currents sweep the area. In order to avoid striking the submerged ledge, which is about 20 feet below mean low water, and to have proper maneuvering area to make the turn, large vessels must steer a course near Seavey Island. However, such a course is restricted by naval-base operations at and between its piers, and vessels must allow sufficient steerageway to avoid collision with naval vessels. Naval vessels are moored abreast of each other at the piers, with as many as six submarines being reported to have been tied abreast of each other at one time. Such mooring reduces the channel width available for maneuvering by merchant vessels. Since all navigation is restricted to slack-water periods, merchant vessels must pass the area while naval vessels are being moved between piers. The Navy has advised that the passage of merchant vessels near its piers to avoid Gangway Rock constitutes a hazard and interferes with the movement of the vessels. Large vessels navigate the river only at high water to avoid grounding on Gangway Rock. This rock is known to have been twice struck by colliers, once in the early 1930's and once during the recent war.

31. The ledge at the southwest point of Badgers Island, at a sharp bend in the channel, is approximately 1,000 feet above the first bridge and 2,000 feet below the second bridge and is located on the northerly side of the channel. The ledge rises abruptly from channel depths of 50 or more feet to about 30 or 35 feet and then shoals to a depth of about 20 feet along the edge of the proposed channel. Because of the position of the opening in the upstream bridge, vessels passing through the bridge must maneuver near the easterly shore in transiting the area just northwest of the island. In proceeding to and from this area the vessels must pass near the ledge at the bend around the island to avoid losing steerageway because of the cross currents which sweep toward the opposite shore. Because of the danger of striking the submerged ledge, loaded deep-draft vessels transit this area only during periods of high water. In January 1948, an out-bound tanker struck Badgers Island ledge to avoid collision with an in-bound tanker carrying 400,000 gallons of gasoline.



32. Boiling Rock is a pinnacle in a ledge area which is located on the easterly bank of the river at a constricted bend about 1.2 miles above the second bridge. The pinnacle rises to a height of 3.5 feet below mean low water at a point about 200 feet from shore. Depths over the ledge areas generally vary from 10 to 30 feet, and the ledge rises abruptly from channel depths of 50 to 60 feet. The ledge occurs directly across the river from the principal industrial developments on the river, namely, the Public Service Co. of New Hampshire's power plants, the Socony-Vacuum Oil Co.'s terminal, and the C. H. Sprague & Son Co.'s coal and oil terminal. The natural constriction of the river at this point is increased by the two wharves serving these companies and by the permanently anchored floating power plant, steamship *Resistance*. The wharves and floating power plant are located along the outer shore of the river's bend toward which the strong currents sweep and are only about 500 feet from the ledge shoal. The restricted channel is further reduced about 100 feet when large vessels are tied up at the wharves. Vessels transiting the area must steer a course near the wharves to provide safe clearance of the ledge and proper maneuvering area to make the turn. However, operations around the wharves restrict such a course, making navigation difficult. Since vessels using the wharves are from 440 to 523 feet in length, the handling of such vessels in docking and in turning for out-bound trips is extremely hazardous. The Atlantic Terminal Sales Corp., located about 2 miles upstream, states that large vessels will not pass the ledge to the company's wharf when vessels are docked in the Boiling Rock area and the expansion of Atlantic Terminal Sales Corp. facilities for deep-draft vessels is dependent upon removal of Boiling Rock ledge. One tanker bound for the terminal struck this ledge about 15 years ago, rupturing its outer shell.

#### WATER POWER AND OTHER SPECIAL SUBJECTS

33. The waterway is tidal. Matters of flood control, water power, or pollution are not pertinent to this report. None of the contemplated work will have any adverse effect on wildlife or shellfish.

#### PLAN OF IMPROVEMENT

34. Consideration has been given to two plans of improvement designated herein as plans A and B, as desired by the local interests for the improvement of Portsmouth Harbor and Piscataqua River.

Plan A would provide:

Removal of ledge-rock at Gangway Rock, the southwest point of Badgers Island, and at Boiling Rock to a depth of 35 feet at mean low water within the limits indicated on plates 1 and 2.

This plan will meet the desires of shipping interests with deep-water terminals located up river as far as Boiling Rock to the extent that it would provide for safer navigation and decrease operational costs for deep-draft vessels utilizing the waterway with load capacities of 10,000 tons or greater. Deep-draft vessels require a channel with a minimum width of 400 feet to provide for proper maneuvering in making the turns and in passing other vessels. A feasible 400-foot-wide channel was laid out, as indicated on the plans accompanying this report between Henderson Point and a point about 1,500 feet

upstream of Mast Cove near the head of natural deep water. The channel limits in the three ledge-rock areas were laid out to provide reasonable navigational conditions with the minimum of ledge-rock removal. The depth of 35 feet at mean low water for ledge removal was selected to provide safe clearance for T-2 tankers which draw up to 32 feet when under way, and which are in general use by the oil industry. The locations of the ledges were determined by hydrographic, topographic, and probing surveys made in July, August, and December, 1949, which indicated there is no appreciable amount of overburden on the ledges.

Plan B would provide:

The removal of two shoal areas, located about 1 mile and 1.8 miles upstream of Boiling Rock, to 35 feet below mean low water within the limits indicated on plate 2.

This plan was considered to provide a 35-foot waterway from Boiling Rock to the Atlantic Terminal Sales Corp. This improvement would permit deep-draft vessels to navigate this reach of the waterway on the slack of low tide as well as the slack of high tide. Field surveys were made of the two shoal areas in May and June 1951. The survey showed that as far as water depths are concerned it was possible for deep-draft vessels to navigate this section of the waterway at high water. Commerce destined to the Atlantic Terminal Sales Corp. is presently carried in small motor tankers with loaded drafts of 10 to 14 feet. It was stated that small tankers are used because of the possibility of damaging deep-draft vessels on the ledge area at Boiling Rock.

#### AIDS TO NAVIGATION

35. The United States Coast Guard has been consulted in regard to establishing aids to navigation from the outer harbor to Mast Cove Rock at the head of the proposed improvements. The estimated costs for establishing the aids and annual maintenance costs for the two plans considered are tabulated below:

Plan	Cost	Maintenance cost
A.....	\$30,000	\$600
B.....	4,000	100
Total.....	34,000	700

#### SHORE-LINE CHANGES

36. The proposed improvements consist of the removal of the outer portions of three ledge-rock areas and the removal of two shoal areas which project into the waterway. The amount of material to be removed in relation to the total cross section of the river at these points is such that there will be no appreciable effect upon existing river and tidal currents. Therefore, the improvement will have no effect upon the shore line.

## ESTIMATES OF FIRST COST

37. Estimates of cost have been prepared for the two plans of improvement considered herein. Dredging quantities are in terms of place measurement and provide for dredging to the proposed project depth in ordinary material and ledge rock, plus an allowance of 2 feet of overdepth in each case. Side slopes of 1 on 3 in ordinary material, and 1 on 1 in ledge rock were used in the estimates. The ledge rock, after blasting, and ordinary material would be removed by a dipper dredge, with disposal in deep water adjacent to the areas. Probings indicate that the ordinary material to be dredged is a dense sand and gravel with a large percentage of stone, which accounts for the high unit price for purposes of a cost estimate. The cost estimates are based on price levels prevailing in June 1951. Unit prices include allowances for engineering, contingencies, inspection, and overhead. The estimates of cost for the two plans are as follows:

*Plan A*

(a) Ledge removal to 35 feet below mean low water:	
1. Gangway Rock: 10,700 cubic yards of ledge, at \$35.....	\$375, 000
2. Southwest point of Badgers Island: 2,650 cubic yards of ledge, at \$35.....	93, 000
3. Boiling Rock: 10,450 cubic yards of ledge, at \$35.....	366, 000
Total cost of ledge removal.....	834, 000
(b) Aids to navigation.....	30, 000
Total estimated cost of plan A.....	864, 000

*Plan B*

(a) Channel depth of 35 feet: Dredging 160,000 cubic yards of sand and gravel, at \$2.....	320, 000
(b) Aids to navigation.....	4, 000
Total estimated cost of plan B.....	324, 000

## ESTIMATES OF ANNUAL CHARGES

38. The estimated annual carrying charges have been computed on an assumed life of 50 years and at interest rates of 3 percent on the Federal investment and 3.5 percent on the non-Federal investment. The annual charges for the improvement considered under plan A have been computed on the basis of the cost of improvement being borne by the United States. In the case of plan B, the annual charges have been computed on a Federal investment of 75 percent and a non-Federal investment of 25 percent. The estimated annual charges are indicated in the following tabulations:

*Plan A*

(1) Federal investment:	
(a) Construction cost (Corps of Engineers)-----	\$834, 000
(b) Aids to navigation (Coast Guard)-----	30, 000
(c) Total Federal investment-----	864, 000
(2) Federal annual carrying charge:	
(a) Interest on item (1) (c)-----	25, 900
(b) Amortization on item (1) (c)-----	7, 700
(c) Estimated cost of annual channel maintenance-----	0
(d) Annual maintenance item (1) (b)-----	600
(e) Total Federal annual carrying charge-----	34, 200
(3) Non-Federal investment-----	0
(4) Non-Federal annual carrying charge-----	0
(5) Total annual carrying charge:	
(a) Federal annual carrying charge-----	34, 200
(b) Non-Federal annual carrying charge-----	0
(c) Total annual carrying charge-----	34, 200

*Plan B*

(1) Federal investment:	
(a) Construction cost (Corps of Engineers)-----	\$240, 000
(b) Aids to navigation (Coast Guard)-----	4, 000
(c) Total Federal investment-----	244, 000
(2) Federal annual carrying charge:	
(a) Interest on item (1) (c)-----	7, 300
(b) Amortization on item (1) (c)-----	2, 200
(c) Estimated cost of annual channel maintenance-----	1, 000
(d) Annual maintenance item (1) (b)-----	100
(e) Total Federal annual carrying charge-----	10, 600
(3) Non-Federal investment-----	80, 000
(4) Non-Federal annual carrying charge:	
(a) Interest on item (3)-----	2, 800
(b) Amortization on item (3)-----	600
(c) Total non-Federal annual carrying charge-----	3, 400
(5) Total carrying charge:	
(a) Federal annual carrying charge-----	10, 600
(b) Non-Federal annual carrying charge-----	3, 400
(c) Total annual carrying charge-----	14, 000

## ESTIMATES OF BENEFITS

39. The improvement of Portsmouth Harbor and Piscataqua River for deep-water navigation will effect material savings in operating costs of deep-draft vessels now using the waterway. The savings that will accrue from the removal of the ledge rock as considered under plan A will be the reduction in tidal delays and transit time, the elimination of delays attributable to one-way traffic, and the elimination of vessel damage. The savings that will accrue from the removal of the shoal areas located approximately 1 mile and 1.8 miles upstream of Boiling Rock as considered under plan B will be savings due to reduction of tidal delays.



## ESTIMATES OF BENEFITS FOR PLAN A

40. Existing terminal developments capable of handling deep-draft shipping are concentrated opposite Boiling Rock, and serve the Public Service Co., the C. H. Sprague & Son Co., and the Socony-Vacuum Oil Co. Improvement of other terminals is said to be dependent on the desired channel improvements. Deep-draft vessels destined to the terminals of Socony-Vacuum Oil Co., Inc., Public Service Co. of New Hampshire, and C. H. Sprague & Son, presently navigate the waterway about  $1\frac{1}{2}$  hours before and after the slack of high water during daylight hours. This is necessary because of the rapid tidal currents which affect the steerage of the vessel and because of the existence of ledge-rock areas at depths of 18 to 20 feet below mean low water along the channel edges. The ledge shoals are at Gangway Rock, at the southwest point of Badgers Island, and at Boiling Rock within the indicated channel limits of the suggested 400-foot channel.

41. Under the existing conditions, due to tidal currents, channel alinement, and the ledge rock, the transiting of the waterway by deep-draft vessels is restricted to one-way traffic. A considerable number of the ships using the harbor are of such size that the deep-draft ships requiring full channel depth would avoid attempting to pass in the restricted channel. In view of the increased use of the waterway by deep-draft vessels, this restriction contributes to a further delay in entering the waterway, which at times necessitates a vessel awaiting high tide the following day. This delay which is attributable to one-way traffic cannot be definitely determined due to the scheduling of the vessels to meet the commercial requirements of the terminals, but it has been estimated that this condition will occur at least once a year, or an average delay of approximately 0.5 hour per vessel trip.

42. An analysis of tide curves relative to daylight hours and the frequency of vessel trips during the seasons of the year, with vessels entering the outside harbor at all times shows that the average tidal and darkness delay are 10.5 hours for the deep-draft vessels now using the waterway.

43. The removal of the ledge rock would allow the deep-draft vessels to transit the waterway on the slack of low water as well as the slack of high water during daylight hours, permit two-way traffic, and reduce the transit time from the outside harbor to the terminal. It is the opinion of the vessel operators that they will not transit the waterway during the darkness hours even though the ledge rock is removed and proper channel markers are installed, because of the channel alinement and the rapid tidal currents.

44. An analysis of the tide curves shows that a tidal and darkness delay of about 5.75 hours will be incurred by deep-draft vessels subsequent to the removal of the ledge rock. It is also estimated that transit time on the waterway will be reduced by about 0.25 hour and that the 0.5-hour average delay now occasioned by the restriction of one-way traffic would be eliminated.

45. The savings in time per deep-draft vessel trip that will accrue to the improvement considered under plan A in the form of delays and transit time are as follows: Tidal delays, 4.75 hours; transit time, 0.25 hour; and elimination of one-way traffic delays, 0.5 hour. This results in a total saving of time in the amount of 5.5 hours.

46. During 1950, 25 tankers and 14 colliers with loaded drafts in excess of 27 feet entered the waterway. The Public Service Co. of New Hampshire has plans for the immediate construction of an additional unit to their power plant which will utilize either oil or coal, requiring six to eight deep-draft vessel trips annually. It is also conservatively estimated that due to population trends and increased per capita use the increased consumption of oil and coal will require an additional five deep-draft vessel trips annually. On this basis, it is estimated that the average yearly use of the waterway over the life of the project will increase to 33 vessel trips by T-2 tankers and 17 vessel trips by 10,000-ton colliers. This deep-draft commercial traffic is in addition to over a hundred vessel trips by United States naval craft, and over a hundred vessel trips by other commercial craft of drafts ranging from 12 feet to 27 feet.

47. The annual benefits in the form of savings in operational cost of deep-draft vessels, which are general in character, to be derived from the removal of the ledge-rock areas are as follows:

17 10,000-ton collier trips, 5.5 hours, at \$82 per hour-----	\$7, 500
33 T-2 tanker trips, 5.5 hours, at \$116 per hour-----	21, 050
Total-----	28, 550

48. Vessels have struck all three ledges in the past 20 years, the last accident occurring in January 1948 when an out-bound tanker hit Badgers Island ledge in avoiding a loaded in-bound tanker. Information obtained concerning the circumstances involved show that weather was not a contributing factor and also that the accident was in no way due to the negligence of the pilots of the vessels. This one accident is reported to have resulted in damages to the vessel amounting to \$300,000, and a loss in operational time of 30 days, or \$120,000. It is considered that the rate of \$4,000 per day is excessive. Based on an average operational cost of \$3,000 per day it is considered that a total of \$90,000 is more reasonable.

49. The specific details concerning the other three accidents, remembered by those associated with the waterway, are not available as to the circumstances involved or the monetary losses suffered. However, it was stated that one of the accidents involved a small tanker bound for the terminal of the Atlantic Terminal Sales Corp. The tanker hit Boiling Rock, rupturing its outer shell, and after unloading at the terminal it was taken to a repair yard. Further details were not furnished.

50. To arrive at an equitable to-date annual vessel damage loss is somewhat complicated by the fact that during the past 20 years the trend has been to an increased use of deep-draft vessels, lack of information concerning the monetary losses involved in three of the reported accidents, increased construction cost index, and the heavy damage incurred by one T-2 tanker. The reported accidents occurred over a period of about 20 years. On this basis it is considered that the average annual vessel damage has amounted to at least \$20,000 for the past 20 years.

51. The probability of accidents occurring on the waterway will be greatly increased because of the increased use of deep-draft vessels. Records of vessel trips pertinent to this waterway indicate that the average annual use of the waterway during the past 20 years by vessels subject to damage from the ledges have been about 10 vessel

trips. During the life of the project it is estimated that there will be 50 deep-draft vessel trips annually over the waterway, which is five times that for the past 20 years. There are no indications that the annual vessel damage will increase in this relationship. While conditions in this case make impractical a firm monetary evaluation of the benefits, in the best judgment of the reporting officer the benefits from removal of ledge rock from within the channel would at least equal the past losses of \$20,000 annually.

52. The general benefits that will accrue to the removal of the ledge obstructions are as follows:

Elimination of vessel damage.....	\$20, 000
Savings in operational costs.....	28, 550
Total.....	48, 550

#### ESTIMATES OF BENEFITS FOR PLAN B

53. There is only one terminal located on this section of the waterway which is the reach of the Piscataqua River from Boiling Rock to Mast Cove. The terminal is located at the head of this section and is operated by the Atlantic Terminal Sales Corp. which is affiliated with the Gulf Oil Corp. The Shell Oil Co. with storage facilities in this same area is a tenant of the terminal. The commerce in the form of petroleum products, destined to the terminal is transported in small self-propelled motor tankers with capacities of 8,000 to 12,500 barrels. The commerce received by the Atlantic Terminal Sales Corp. originates from Chelsea River, Boston Harbor, and that received by the Shell Oil Co. originates from Portland Harbor.

54. The harbor pilot and the marine department of the Gulf Oil Corp. have indicated that it is physically possible for deep-draft vessels to navigate the waterway on the slack of high water up to the terminal. However, it is considered impracticable to use deep-draft vessels because of the risk of vessel damage that would be run for the relative volume of commerce involved. The Gulf Oil Corp. has investigated the possibilities of expanding their facilities in the area to provide the necessary storage and deep-water terminal. Consideration of the plans has been deferred pending the improvement of the waterway, particularly the removal of the ledge-rock areas considered in this report.

55. Statements furnished at the public hearing indicate the Atlantic Terminal Sales Corp. anticipates an increase in the receipts of petroleum products of nearly 1 million tons annually subsequent to the improvement of the waterway and the expansion of their terminal facilities to accommodate deep-draft vessels. A study of transportation maps for the State of New Hampshire shows that Portsmouth Harbor is ideally located for the distribution of petroleum products throughout the State, particularly to the west and north. Preliminary census figures for 1950 shows the population of the State of New Hampshire to be about 530,000. It is estimated that about 35 percent of the population is within the area tributary to Boston, Mass. In view of the total population and the per capita use of petroleum products, it is considered that such an expansion is not probable. In addition, Portsmouth Harbor receives T-2 tankers at another major oil company terminal, a present distributor in the same tributary area. Therefore, it is assumed that an expansion at the up-river

terminal will be only through an increased population and increased per capita use in the general area which it is estimated will average approximately 10 percent over the life of the project.

56. It is recognized that the savings in unit costs of the petroleum products destined to the Atlantic Terminal Sales Corp. would be greater than those to the terminals located on the waterway considered in plan A because of the modes of transportation now employed. Statements by interested parties and information obtained from field surveys indicate that deep-draft tankers could transit the upper waterway at high water under existing conditions. Therefore, in view of the foregoing condition, the savings in transportation costs which would result in general benefits pertinent to the tributary as a whole, would be only the savings in tidal delays for deep-draft tankers or the theoretical equivalent of T-2 tankers for the commerce destined to the Atlantic Sales Terminal.

57. During the year 1950, about 50,000 tons of petroleum products were received by the Atlantic Sales Terminal Corp. and 26,000 tons by the Shell Oil Co., a tenant of the terminal. This amount of commerce plus an expansion over the life of the project averaging 10 percent would be the equivalent to the commerce which would be carried by six T-2 tanker trips annually. The improvement of this reach of the waterway to a depth of 35 feet would allow deep-draft vessels to navigate on the slack of low water. Tidal delays discussed in paragraphs 42 to 45 show that there would be a savings in transportation time in the amount of 4.75 hours. The benefits that would accrue to the improvement of this section of the waterway, if the removal of the ledge rock is also assumed to have been effected as considered under plan A, are as indicated below:

$$6 \text{ trips} \times 4.75 \text{ hours} \times \$116 = \$3,300$$

#### COMPARISON OF BENEFITS AND COSTS

58. The estimated general benefits and the estimated annual charges for the two plans of improvement result in the benefit-cost ratios indicated below:

Plan	Estimated benefits	Estimated annual charges	Benefit-cost ratio
A .....	\$48,550	\$34,200	1.4
B .....	3,300	14,000	0.2

#### PROPOSED LOCAL COOPERATION

59. The benefits to be derived from the improvements considered as plan A are sufficiently general to warrant the construction of the improvement at the expense of the United States. However, local interests should be required to furnish without cost to the United States all lands, easements, and rights-of-way necessary for the accomplishment of the improvement, and to hold and save the United States free from all damages resulting from the construction and the improvement.

60. The section of the waterway considered in plan B serves two distributors at one terminal. It is recognized that local benefits would accrue to the considered improvement because deep-draft



vessels would be used and the expansion of terminal facilities would become practicable. As indicated in paragraph 38 for purposes of estimating the annual carrying charges, a cash contribution of 25 percent of the initial cost has been estimated as reflecting the relationship of local to total benefits to be received. This contribution denotes generally the nature of local cooperation that would be required under plan B, but in view of the unfavorable benefit-cost ratio, detailed requirements for local cooperation have not been prescribed, nor has the ability or willingness of local interests to meet such requirement been sounded.

#### ALLOCATION OF COSTS

61. The benefits accruing from the improvement considered under plan A being general in character, the entire cost should be borne by the United States. The allocation of costs would be as follows:

Corps of Engineers	\$834, 000
Coast Guard	30, 000
Local interests	0
Total	864, 000

62. The section of the waterway considered in plan B serves two distributors at one oil terminal. Although deep-draft navigation of the upper river at high water is possible, the channel conditions have an adverse influence on any plans for expansion beyond the present relatively limited commerce on this channel reach, now carried in shallow-draft tankers. Petroleum is now received in deep-draft tankers at terminals on the lower river. Improvement of the river as envisioned under plan B would, therefore, be of general benefit in reduction of costs of transportation of oil to the area only to the extent that deep-draft navigation would be made practicable at slack low water, rather than only at slack high water. In view, therefore, of the undoubted local benefit to be derived, it has been determined that 25 percent of the costs, other than for aids to navigation, of the improvement considered under plan B should be borne by local interests. The allocation of costs under plan B would, therefore, be as follows

Corps of Engineers	\$240, 000
Coast Guard	4, 000
Local interests	80, 000
Total	324, 000

#### COORDINATION WITH OTHER AGENCIES

63. All Federal, State, and local agencies having interests in the development and use of the waterway were notified of the public hearing on the desired improvement held July 12, 1949. Subsequent to the development of the plans of improvement proposed herein, local interests have been consulted and have expressed a general agreement with plan A.

#### DISCUSSION

64. The mouth of the Piscataqua River is Portsmouth Harbor. The river forms a portion of the boundary of the States of New Hampshire and Maine. This waterway has a tortuous natural channel which affords depths up to 70 feet and generally in excess of 40 feet at mean low water to a point about 3 miles above the upper limit of Portsmouth Harbor. This limit is the second of the two

bridges crossing the river. The river, serving as the drainage channel of very large tidal basis, is subject to very strong currents which limit the navigation of the river by large vessels to periods of 3 hours near slack water at high tide, comprising 1½ hours before and after slack water. Navigation of the river is made extremely hazardous by submerged ledges which occur at bends and constricted areas in the winding channel.

65. All previous studies for the improvement of the waterway have concerned the removal of ledge rock and the construction of works to improve current conditions. All work authorized for the improvement of the waterway is within the limits of Portsmouth Harbor and was completed in 1892. This work included the removal of ledge rock in two areas in Portsmouth Harbor presently under consideration. A portion of Gangway Rock was removed to a depth of 20 feet and a portion of the southwest point of Badgers Island to 18 feet. There has been no maintenance required on the authorized work.

66. Fifty-nine years ago when the improvements were completed, the waterway was used by shallow-draft vessels plying to and from the wharves along the water front of the city of Portsmouth. Since that time, the commercial use of the waterway has completely changed and the deep-water reach of the river above the city has been developed for industrial use. In this river reach, there are presently located the bulk oil terminals of the Esso Standard Oil Co., the Socony-Vacuum Oil Co., Inc., and the Atlantic Terminal Sales Corp., which distributes Gulf Oil products and rents storage to the Shell Oil Co., the coal and oil terminal of the C. H. Sprague & Son Co.; the 30,000-kilowatt floating power plant and the 40,000-kilowatt mercury vapor plant of the Public Service Co. of New Hampshire; and the manufacturing plant of the National Gypsum Co. The Socony-Vacuum Oil Co., Inc., the C. H. Sprague & Son Co., and the Public Service Co. receive coal and oil by vessels drawing up to 32 feet when under way. The Public Service Co. completed the construction of the 40,000-kilowatt mercury vapor plant in 1949. This is the first of three units designed for its site. The company has indicated that a second unit will be completed for operation by 1953, with the third unit contingent on future load demands. In addition, the Atlantic Terminal Sales Corp. plans to construct increased storage capacity, amounting to 280,000 barrels, and a terminal to allow the use of deep-draft tankers. The planned expansion of existing facilities, the increasing demand for gasoline and fuel oils, the growing use of deep-draft vessels in coast-wise commerce, and the land available for further commercial development on the natural deep waterway indicates that the deep-draft vessel traffic will continue to increase.

67. The United States naval base, located in Portsmouth Harbor, receives 6 to 12 deep-draft tankers annually in addition to submarines, cruisers, and aircraft carriers. Vessels have been brought in and out of the navy yard for many years without any serious casualties. About 1,000 feet of water separates the yard and the Gangway Rock which necessitates the exercise of great care in handling vessels approaching and leaving the dock. The danger of Gangway Rock constitutes a serious hazard both to merchant vessels as well as naval vessels. The removal of the rock would greatly increase the efficiency of the naval base.

68. The growing use of 10,000-ton, or larger, tankers and colliers in lieu of smaller vessels has increased the dangers experienced in navi-

gating the waterway. These vessels drawing up to 32 feet when under way and varying up to 525 feet in length require greater maneuvering areas to negotiate the turns in the river and to pass through constricted areas. The greatest difficulties in navigating the waterway are encountered at two of the ledge-rock areas in Portsmouth Harbor, previously excavated for shallow-draft vessels, and at one ledge-rock area in the Piscataqua River. Each of these three ledges rises abruptly from deep water.

69. Deep-draft vessels are endangered in transiting the Gangway Rock area because they must avoid the ledge, navigate against the cross currents, and avoid movement of vessels at the wharves of the United States naval base. During periods of naval activity this area is particularly constricted since as many as six vessels are tied abreast of each other at the upstream wharf. Two colliers have struck Gangway Rock.

70. Vessels proceeding past Badgers Island encounter strong currents and have to sail close to the southwest point of the island to maintain steerageway in passing to and from the area northwest of the island where they must maneuver into position to pass through the bridges above the island. One major accident occurred on this ledge when an out-bound tanker grounded while attempting to avoid collision with an in-bound tanker carrying gasoline.

71. The ledge at Boiling Rock, rising to a pinnacle 3.5 feet below the water surface, has always constituted a hazard to navigation. The erection of a major power plant and two fuel terminals directly across the river has served to make this a most critical area on the river. Shallow water over the ledge, the narrow width of the river at this point, the strong currents sweeping toward the wharves, and the mooring of vessels at the wharves serve to make the river reach difficult to navigate. One tanker bound for the Atlantic Terminal Sales Corp., 2 miles upstream, struck Boiling Rock. The company has stated that it cannot develop a deep-water terminal until this ledge is removed.

72. Safe navigation of this waterway by deep-draft vessels requires a channel at least 400 feet wide, with easy bends to allow maneuvering against tidal and cross currents and to allow passage of in-bound and out-bound vessels. The estimates of cost were based on providing a channel 35 feet deep to allow deep-draft vessels to transit the waterway on the slack water of low tide. The 35-foot depth is predicated on the basis that a T-2 tanker has a draft of 30 feet 2 inches in a stationary position plus the following factors: 1 to 2 feet for uneven loading; 1 to 1.5 feet for "squat" when under way; 2 to 3 feet of clearance between the keel and channel bottom; and an allowance for minus tides.

73. As shown on the accompanying plans, a channel 400 feet wide may feasibly be laid out on the waterway so that natural deep water is obtained at all points except at the three ledge-rock areas, and two areas about 1 mile and 1.8 miles above Boiling Rock. In the three ledge-rock areas where improvements are desired, the channel is laid out to provide reasonably easy bends with the minimum amount of ledge-rock removal and to increase the width of the natural deep-water channel by 50 to 100 feet at such points. This plan does not afford any additional widening as a turning area opposite the wharves at the Public Service Co.'s power station where out-bound light vessels are turned in midstream. It is considered that such vessels could be

turned in the natural wide river reach approximately 2,000 feet upstream where depths up to 70 feet occur. Deep-water width for turning also exists opposite the Atlantic Terminal Sales Corp. terminal.

74. Local interests requested that ledge at Gangway Rock and Badgers Island be removed to a depth of 30 to 35 feet and at Boiling Rock to a depth of 30 feet. The lesser depth at Boiling Rock area is probably due to the customary turning of light vessels as discussed in the preceding paragraph. However, the transit of deep-draft vessels to terminals immediately opposite Boiling Rock, as well as further upstream, would require the same channel depths as at the other two areas. It has been determined that the estimated benefit-cost ratio of 1.4, exclusive of vessel traffic upstream of Boiling Rock, warrants the removal of the ledges to a depth of 35 feet which will allow deep-draft vessels to transit the waterway on the slack of low water. Broken ledge rock may be deposited in the adjacent deep-water areas. Since there is no appreciable amount of overburden on the ledges, which rise abruptly from deep water and are swept by swift tidal currents, it is not anticipated that shoaling will take place in the dredged areas in the future.

75. A channel lay-out has been indicated on the plans accompanying this report, from Henderson Point to a point about 1,500 feet beyond Mast Cove. The indicated lay-out is suggested as being feasible for establishing aids to navigation in the natural deep-water reaches of the river, and establishes channel limits in the areas of considered improvements. Evidence submitted at the hearing, and obtained in the field, indicates that some difficulties may be encountered in navigating the waterway due to inadequate channel marking. It is believed that markers establishing channel limits outside of the areas considered herein for improvement would be of great assistance to navigation interests. Except as noted in paragraph 73, there are no known shoals which would afford depths less than 35 feet in this channel. However, the continued existence of rock shoals outside the channel limits requires that these limits be marked for the safety of the expected future commerce.

76. The providing of an adequate channel in the three ledge-rock areas designated as plan A will remove the constant danger of vessels striking the submerged ledges which in the past 20 years have caused damages to vessels approximating \$20,000 per year. It has been stated that Portsmouth Harbor has the highest per ton risk of any harbor in this section of the country. While the annual vessel damage for the past 20 years was predicated on one costly accident, it was the consensus of opinion of the ship operators that a similar accident could very easily reoccur. Based on the use of the waterway by deep-draft vessels during the past 20 years and the estimated use of the waterway over the life of the project, it is estimated that the removal of the ledge-rock areas from within the channel will result in the elimination of vessel damage at least in the amount of \$20,000 annually. This elimination of vessel damage is considered to be a general benefit accruing to the improvement. Provision of proper navigation aids will afford added protection to future shipping from rock shoals outside the channel.

77. The removal of the ledge-rock areas will also result in savings of operational costs of deep-draft vessels in the form of savings in time by decreasing the tidal delays and transit time, and eliminating de-



lays due to the restrictions of one-way traffic. The total savings in time is estimated to be 55 hours per deep-draft vessel trip. Based on the use of the waterway by deep-draft vessels in 1950, proposed expansion of power plants, and increased use of petroleum products, it is estimated that the average annual use of the waterway over the life of the project will be as follows:

17 10,000-ton collier trips

33 T-2 tanker trips

The savings in operational costs to the above vessel traffic will result in annual benefits in the amount of \$28,550, which are general in character.

78. Since a large part of the commerce comprises the transportation of petroleum products, there is a constant danger that highly inflammable gasoline and oil will be spread along the water front of the densely populated city of Portsmouth if an accident occurs. This condition exposes the city to a very grave fire hazard which would be of catastrophic proportions. The removal of the ledge-rock areas will remove the principal danger of such an occurrence.

79. The total first cost of the ledge removal considered under plan A is estimated to be \$864,000 and the annual carrying charge to be \$34,200, which includes the cost of establishing and maintaining aids to navigation. The benefit-cost ratio for this plan is estimated to be 1.4.

80. The provision of an adequate and properly marked channel between Boiling Rock and Mast Cove, designated as plan B, would permit deep-draft vessels to transit the waterway up to the Atlantic Terminal Sales Corp. on the slack of low water as well as on the slack of high water. While present commerce is carried in small tankers, it was indicated that shippers would use deep-draft vessels if the ledge removal under plan A were effected. Field surveys show that the waterway upstream of Boiling Rock could be transited by deep-draft vessels on the slack of high water. It will be noted that the deep-water terminals in the vicinity of Boiling Rock receive deep-draft vessels despite the risk of vessel damage. Therefore, it is logical to assume that the method of transportation now employed by the users located upstream of Boiling Rock is a matter of policy.

81. The benefits to accrue to the improvement considered as plan B have been computed on the basis that deep-draft vessels could navigate this section of the waterway under existing conditions. The benefit will, therefore, be in the form of tidal delays or the difference in the estimated tidal delay that would be encountered before and after improvement. The delay would be the same as that computed for plan A, which is 4.75 hours. It is estimated that the future anticipated commerce destined to the Atlantic Terminal Sales Corp. could be carried in the equivalent of six T-2 tanker trips annually. On this basis, the benefits, which are general in character, are estimated at \$3,300 annually, resulting in a benefit-cost ratio of 0.2. If the anticipated commerce to the terminal was threefold to that estimated above, the benefit-cost ratio would be only about 0.6.

82. It is recognized that considerable local benefits would accrue from savings in transportation costs of the petroleum products should Atlantic Terminal Sales Corp. elect to receive products in deep-draft tankers in lieu of the tankers now employed. The consideration of such benefits in justification of Federal improvement of the river is unwarranted because of the fact that the waterway now can be

transited by deep-draft vessels and that the operators on the section considered under plan A now use deep-draft vessels. If there were sufficient general benefits to warrant the improvement under plan B, it is considered that local interests should make a cash contribution of 25 percent of the initial cost in recognition of the local benefits to be derived. Definite indications of the attitude of local interests toward such a contribution have not been ascertained in view of the lack of general benefits.

83. If the improvement under plan B were to be accomplished, it would be also necessary for the local interests to give assurances that an adequate deep-draft terminal would be provided.

84. The total first cost of the improvement considered under plan B is estimated to be \$324,000 and the annual charges to be \$14,000, which includes the cost of establishing and maintaining aids to navigation.

#### CONCLUSIONS

85. The division engineer concludes that modification of the existing project by removal of ledge rock in the vicinity of Gangway Rock, the southwest point of Badgers Island, and Boiling Rock, to allow safe navigation of this section of the waterway by deep-draft vessels is warranted. He further concludes that modification of the existing project by removal of the two shoal areas to 35 feet below mean low water located about 1 mile and 1.8 miles upstream from Boiling Rock is not economically justified at this time.

86. The removal of ledge-rock areas to 35 feet below mean low water within the limits indicated on the plans accompanying this report can be completed at an estimated cost of \$834,000 for new work plus \$30,000 for aids to navigation. The ratio of 1.4 to 1 for estimated annual evaluated benefits to estimated annual carrying charges indicates the improvement is economically justified.

87. The nature of the benefits pertinent to general navigation in the form of elimination of vessel damage and savings in operational costs warrants removal of the ledge-rock areas at the expense of the United States. If the project is authorized, funds for the improvement should be appropriated in one fiscal year to secure economical prosecution of the work.

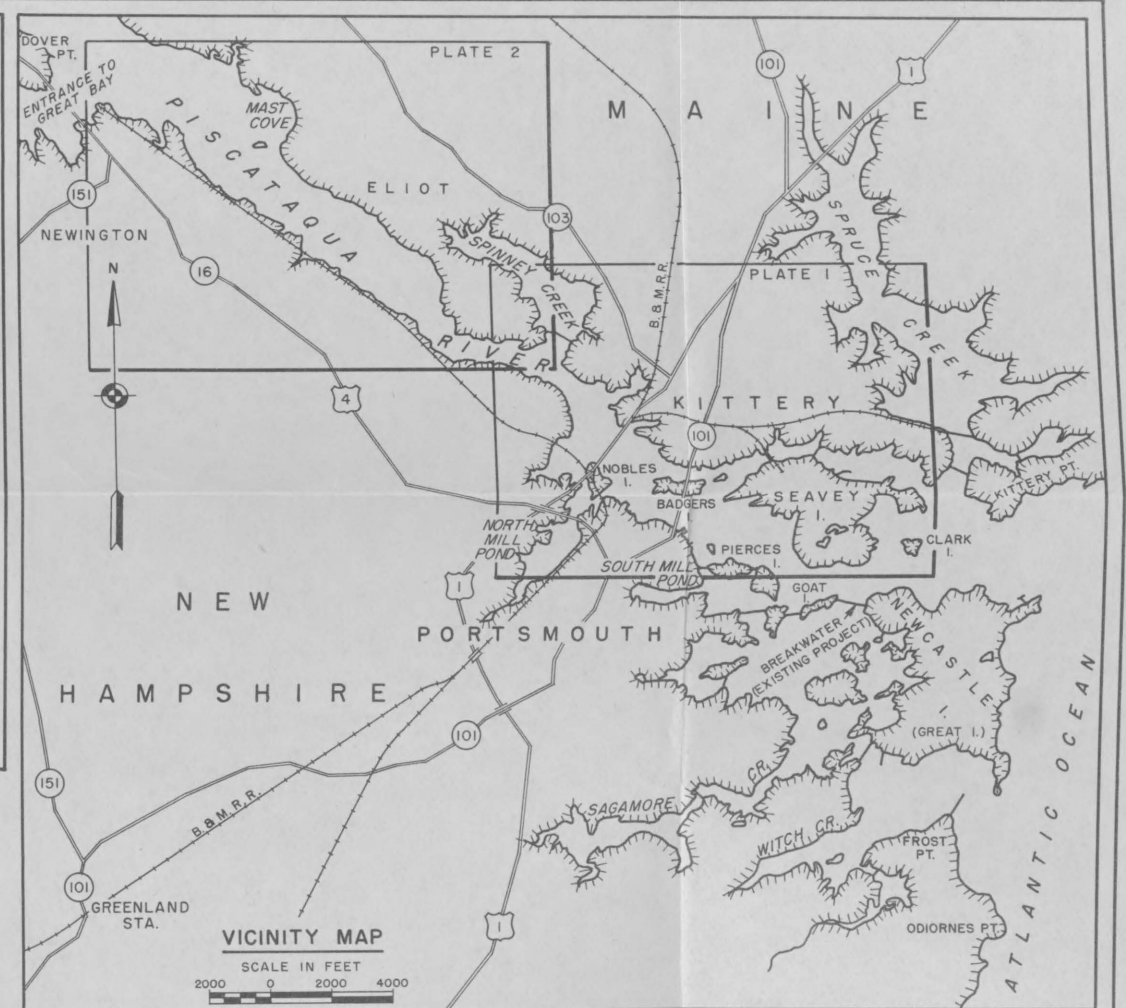
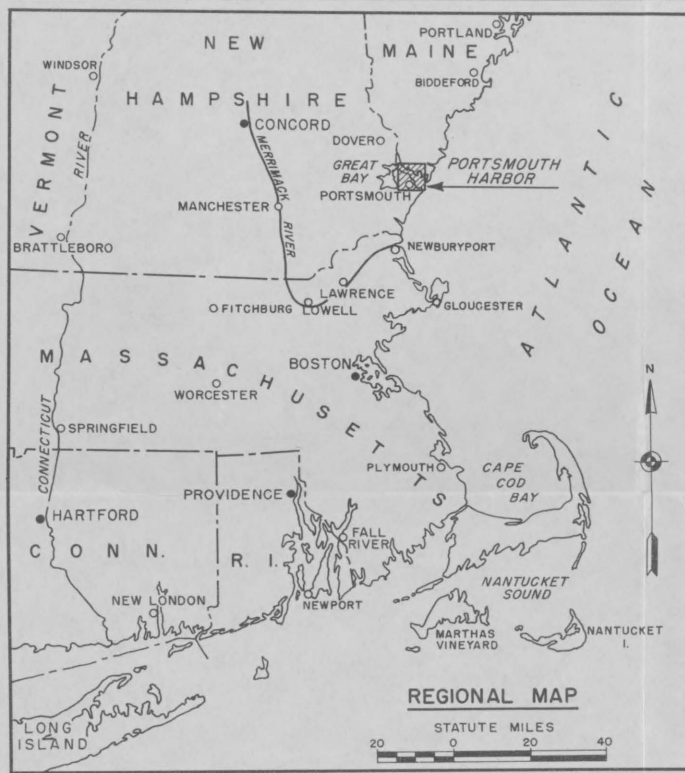
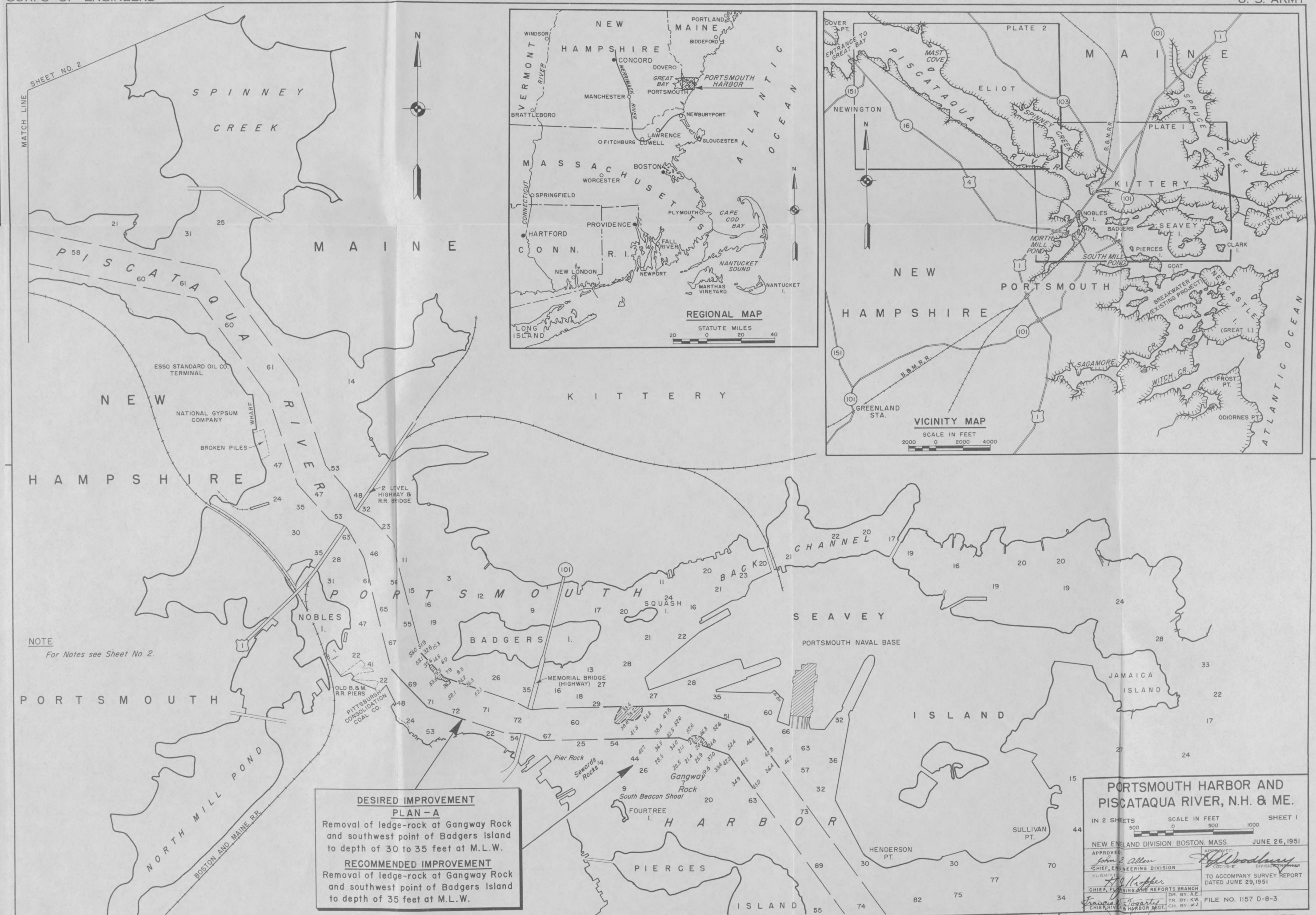
#### RECOMMENDATION

88. It is recommended that the existing project for Portsmouth Harbor and Piscataqua River, N. H. and Maine, be modified to provide for the removal of ledge-rock areas in the vicinity of Gangway Rock, the southwest point of Badgers Island, and Boiling Rock to 35 feet below mean low water, all as generally shown on plates 1 and 2. The removal of the ledge rock is estimated to cost \$834,000 with no maintenance required, exclusive of costs of aids to navigation.

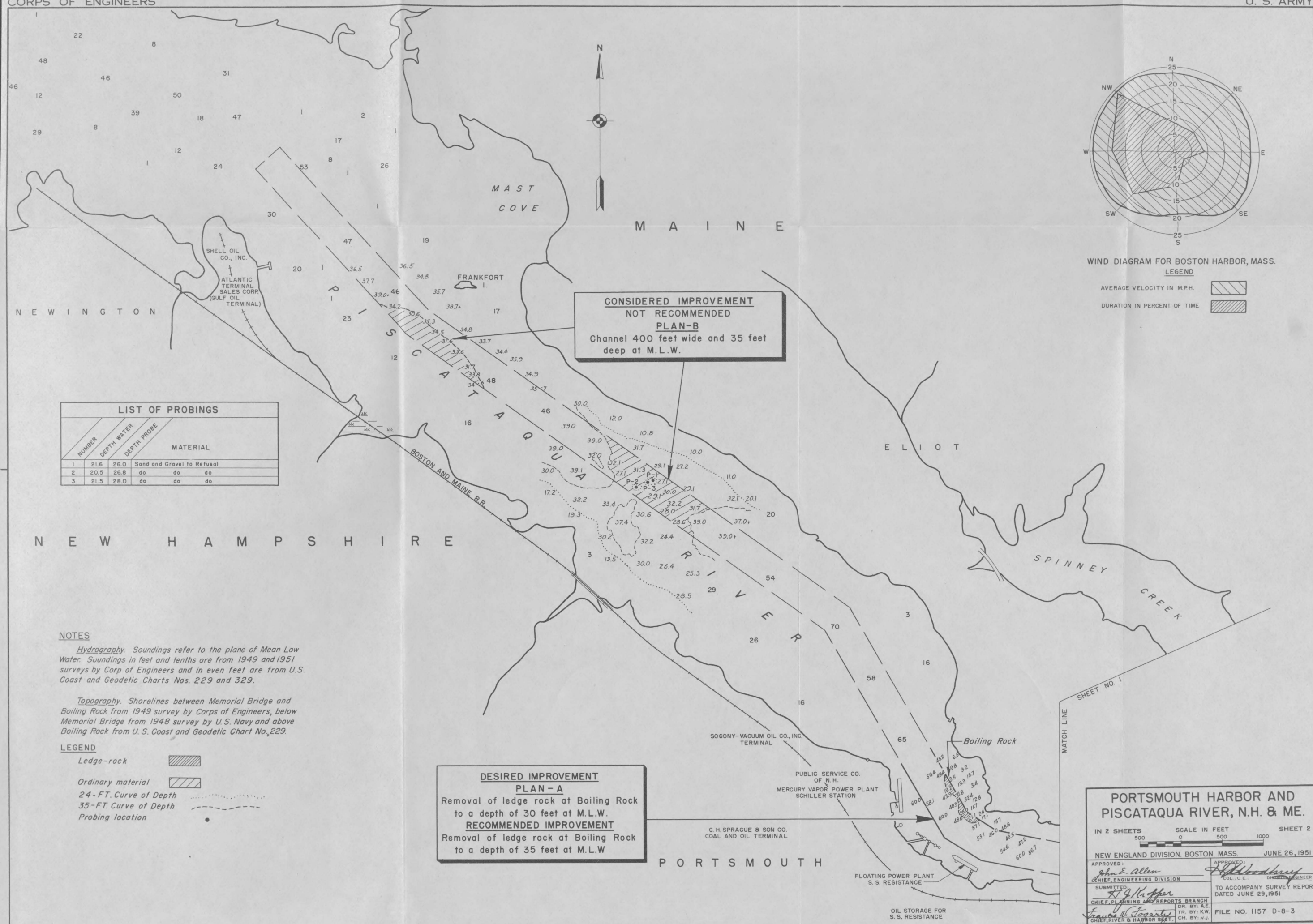
89. Modification is recommended subject to the condition that local interests furnish free of cost to the United States, all lands, easements, and rights-of-way necessary for the accomplishment of the improvement and hold and save the United States free from damages due to the construction works.

H. J. WOODBURY,  
*Colonel, Corps of Engineers,*  
*Division Engineer.*









**CONSIDERED IMPROVEMENT  
NOT RECOMMENDED  
PLAN-B**  
Channel 400 feet wide and 35 feet  
deep at M.L.W.

LIST OF PROBINGS				
NUMBER	DEPTH WATER	DEPTH PROBE	MATERIAL	
1	21.6	26.0	Sand and Gravel to Refusal	
2	20.5	26.8	do do do	
3	21.5	28.0	do do do	

## NOTES

**Hydrography.** Soundings refer to the plane of Mean Low Water. Soundings in feet and tenths are from 1949 and 1951 surveys by Corps of Engineers and in even feet are from U.S. Coast and Geodetic Charts Nos. 229 and 329.

**Topography.** Shorelines between Memorial Bridge and Boiling Rock from 1949 survey by Corps of Engineers, below Memorial Bridge from 1948 survey by U.S. Navy and above Boiling Rock from U.S. Coast and Geodetic Chart No. 229.

## LEGEND

Ledge-rock

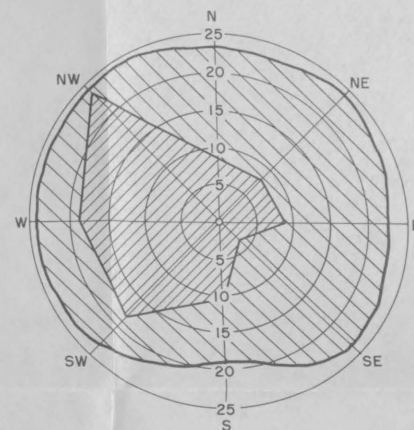
Ordinary material

24-FT. Curve of Depth

35-FT. Curve of Depth

Probing location

**DESIRED IMPROVEMENT  
PLAN-A**  
Removal of ledge rock at Boiling Rock  
to a depth of 30 feet at M.L.W.  
**RECOMMENDED IMPROVEMENT**  
Removal of ledge rock at Boiling Rock  
to a depth of 35 feet at M.L.W.



WIND DIAGRAM FOR BOSTON HARBOR, MASS.

## LEGEND

AVERAGE VELOCITY IN M.P.H.

DURATION IN PERCENT OF TIME

